



Serial No. 09/645,903

Amendments to the Claims:

All claims have been amended herein. Please note that all claims currently pending and under consideration in the referenced application are shown below. Please enter these claims as amended. This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims:

1. (currently amended) A metal polymer residue-free and oxide polymer residue-free contact opening in a dielectric layer for a semiconductor device extending from an upper surface of the dielectric layer to a substantially damage-free metal-containing conductive pad, the opening having substantially parallel, residue-free sidewalls extending from the upper surface of the dielectric layer to the substantially damage-free metal-containing conductive pad, the opening formed by a method comprising:

providing a semiconductor substrate having a metal-containing conductive pad;

forming the dielectric layer over the semiconductor substrate and the metal-containing

conductive pad with at least one opening extending from an upper surface of the

dielectric layer to the metal-containing conductive pad and including a residue residing within the at least one opening;

applying nitric acid within the at least one opening; and

subsequently applying a phosphoric acid-containing solution within the at least one opening.

2. (currently amended) A contact within a metal polymer residue-free and oxide polymer residue-free opening in a dielectric layer for a semiconductor device extending from an upper surface of the dielectric layer to a metal-containing conductive pad, the metal-containing conductive pad substantially damage-free, the opening having substantially parallel, residue-free sidewalls extending from the upper surface of the dielectric layer to the metal-containing conductive pad and formed by a method comprising:

providing a semiconductor substrate having a metal-containing conductive pad;

forming the dielectric layer over the semiconductor substrate and the metal-containing

conductive pad with at least one opening extending from an upper surface of the dielectric layer to the metal-containing conductive pad, and wherein a residue resides within the at least one opening;

applying a nitric acid within the at least one opening;

subsequently applying a phosphoric acid-containing solution within the at least one opening; and

disposing conductive material within the at least one opening.

3. (currently amended) A metal polymer residue-free and oxide polymer residue-free contact opening in a dielectric layer and a barrier layer for a semiconductor device comprising a semiconductor substrate having a substantially damage-free metal-containing conductive pad under the dielectric layer and the barrier layer, the metal polymer residue-free and oxide polymer residue-free contact opening defined by residue-free sidewalls and formed by a method comprising:

providing a semiconductor substrate having a metal-containing conductive pad;

forming the barrier layer over the semiconductor substrate and the metal-containing conductive pad;

forming the dielectric layer over the barrier layer;

forming a first via portion through the dielectric layer to expose a portion of the barrier layer, the formation of the first via portion forming an oxide polymer residue within the first via portion;

forming a second via portion through the exposed portion of the barrier layer, the formation of the second via portion forming a metal polymer residue within the first and second via portions;

applying nitric acid within the first and second via portions to remove the metal polymer residue;

and

subsequently applying a phosphoric acid-containing solution within the first via portion to remove the oxide polymer residue.

4. (currently amended) A metal polymer residue-free and oxide polymer residue-free contact opening in a dielectric layer and a barrier layer above a metal-containing conductive

pad for a semiconductor device, the metal-containing conductive pad substantially free of charging damage, the metal polymer residue-free and oxide polymer residue-free contact opening defined by residue-free sidewalls and formed by a method comprising:

providing a semiconductor substrate having a metal-containing conductive pad;

forming the barrier layer over the semiconductor substrate and the metal-containing conductive pad;

forming the dielectric layer over the barrier layer;

forming a first via portion through the dielectric layer to expose a portion of the barrier layer, the formation of the first via portion forming an oxide polymer residue within the first via portion;

applying a phosphoric acid-containing solution within the first via portion to remove the oxide polymer residue;

forming a second via portion through the exposed portion of the barrier layer, the formation of the second via portion forming a metal polymer residue within the first and second via portions; and

applying a nitric acid-containing solution within the first and second via portions to remove the metal polymer residue.

5. (currently amended) A metal polymer residue-free and oxide polymer residue-free contact opening in a dielectric layer over a substantially damage-free metal-containing conductive pad for a semiconductor device extending from an upper surface of the dielectric layer to the metal-containing conductive pad, the opening having substantially parallel, residue-free sidewalls extending from the upper surface of the dielectric layer to the metal-containing conductive pad, the opening formed by a method comprising:

providing a semiconductor substrate having a metal-containing conductive pad;

forming the dielectric layer over the semiconductor substrate and the metal-containing conductive pad with at least one opening extending from an upper surface of the dielectric layer to the metal-containing conductive pad, and wherein a residue resides within the at least one opening;

applying nitric acid within the at least one opening; and

subsequently applying a phosphoric acid solution including a fluorine-containing component within the at least one opening.

6. (currently amended) A contact within a metal polymer residue-free and oxide polymer residue-free opening in a dielectric layer for a semiconductor device extending from an upper surface of the dielectric layer to a substantially damage-free metal-containing conductive pad, the opening having substantially parallel, residue-free sidewalls extending from the upper surface of the dielectric layer to the metal-containing conductive pad, the contact formed by a method comprising:

providing a semiconductor substrate having a metal-containing conductive pad;

forming the dielectric layer over the semiconductor substrate and the metal-containing conductive pad with at least one opening extending from an upper surface of the dielectric layer to the metal-containing conductive pad, and wherein a residue resides within the at least one opening;

applying a nitric acid within the at least one opening;

subsequently applying a phosphoric acid solution, including a fluorine-containing component, within the at least one opening; and

disposing conductive material within the at least one opening.

7. (Canceled)

8. (currently amended) A metal polymer residue-free and oxide polymer residue-free contact opening in a dielectric layer and a barrier layer for a semiconductor device including a semiconductor substrate having a substantially damage-free metal-containing conductive pad under the dielectric layer and the barrier layer, the metal polymer and oxide polymer residue-free contact opening defined by residue-free sidewalls and formed by a method comprising:
providing a semiconductor substrate having a metal-containing conductive pad;
forming the barrier layer over the semiconductor substrate and the metal-containing conductive pad;
forming the dielectric layer over the barrier layer;
forming a first via portion through the dielectric layer to expose a portion of the barrier layer, the formation of the first via portion forming an oxide polymer residue within the first via portion;
forming a second via portion through the exposed portion of the barrier layer, the formation of the second via portion forming a metal polymer residue within the first and second via portions;
applying nitric acid within the first and second via portions to remove the metal polymer residue;
and
subsequently applying a phosphoric acid solution including a fluorine-containing component within the first via portion to remove the oxide polymer residue.

9. (currently amended) A metal polymer residue-free and oxide polymer residue-free contact opening in a dielectric layer and a barrier layer above a metal-containing conductive pad for a semiconductor device, the metal-containing conductive pad substantially damage-free, the metal polymer residue-free and oxide polymer residue-free contact opening defined by residue-free sidewalls and formed by a method comprising:
providing a semiconductor substrate having a metal-containing conductive pad;
forming the barrier layer over the semiconductor substrate and the metal-containing conductive pad;

forming the dielectric layer over the barrier layer;
forming a first via portion through the dielectric layer to expose a portion of the barrier layer, the formation of the first via portion forming an oxide polymer residue within the first via portion;
applying a solution including a fluorine-containing component within the first via portion to remove the oxide polymer residue;
forming a second via portion through the exposed portion of the barrier layer, the formation of the second via portion forming a metal polymer residue within the first and second via portions; and
applying nitric acid within the first and second via portions to remove the metal polymer residue.